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ABSTRACT

Designed as an introduction to a symposium on the appropriateness of mastery learning as a technique of social studies instruction, this paper reviews research on the variables related to mastery learning in order to provide a basis for systematic symposium discussion. Brief research reviews are included on the following variables: materials, instructional procedures, criteria for mastery, teacher characteristics, pupil characteristics, classroom environment, duration of mastery sequence, and management problems. Appendix A contains a more extensive list of variables for further discussion, and Appendix B indicates a hypothetical and cumulative research sequence which is necessary to establish a body of reliable knowledge about mastery learning. Brief reviews of the four research studies which were presented at the symposium are included in Appendix C. A bibliogrpahy of related research on mastery learning is also included. (DE)

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MAY 25 1976

IS A MASTERY LEARNING MODEL APPROPRIATE TO THE SOCIAL STUDIES?

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Symposium of the AERA Special Interest Group
Research in Social Studies Education
San Francisco, April 21, 1976

Participants: Marion J. Rice, Chairman
Gloria Contreras, University of Texas, Austin
Geoffrey Jones, Memorial University, Newfoundland
James Fagan, University of Texas at Permian Basin
Robert Myers, West Georgia College

Discussants: James H. Block, University of California at Santa Barbara
Ian Allen, Simon Fraser University

OBJECTIVE

The purpose of the symposium is to examine the application of the mastery for learning paradigm (Bloom, 1968; Block, 1971, 1974) to instruction in content drawn from the social science disciplines. This issue is a critical one not only to social studies, but to education in general, since each year a large proportion of students fail to succeed in school tasks, or achieve at a low performance level. Low performance is cumulative, so that unsuccessful students fall further behind in their school tasks the longer they remain in school. While mastery procedures have been recommended as especially appropriate for the low aptitude student, mastery procedures may also be appropriate to a wider range of school populations. In 1975, the Educational Testing Service for the first time admitted that the decline in Scholastic Aptitude Test Scores was a real decline. This decline has been taking place in a decade characterized by a heavy emphasis on discovery, inquiry, and problem-solving modes, not only in the social studies but in all school disciplines. Is it time that serious attention be given to other teaching alternatives, such as mastery learning?

This symposium will examine four of the mastery learning studies conducted under the auspices of the Geography Curriculum Project, University of Georgia. While reviews of mastery learning research, such as that of Block (1971) and Slater and den Broeder (1973) tend to indicate that mastery procedures raised the level of achievement, research in mastery learning in the social studies has been limited. At the time this cycle of four studies was initiated, only Gaines (1971), in association with the Georgia Anthropology Curriculum Project, had completed a mastery learning study in pre-college social studies. Since then five additional studies have been concluded, none of which have indicated that the alleged mastery procedures were able

to overcome differences in aptitude brought to the treatment by the learner, whether the unit of analysis was the individual (Wyckoff, 1974; Myers, 1975) or some variant of a group (Jones, 1974; Contreras, 1975; Fagan, 1975).

It is hoped that the symposium will not merely describe the results of four research studies, but address itself to the adequacy of the treatment procedures and the appropriateness of the research design and data analyses. In particular, the symposium will confromt the issue of whether favorable results reported in the name of mastery reflect comparisons of good teaching versus poor teaching. This panel will also address itself to the issue of whether social science content might be conceptually linear and therefore not amendable to the learning-to-learn advantage attributed to mastery for subject matter which is presumed to be hierarchically structured (e.g., Block, 1970). Finally, note will be taken of the relationship of the mastery paradigm to the more popular construction of Competency or Performance Based Education C/PBTE.

There will be five presentations and two critiques. In the first presentation, Rice will describe variables related to mastery learning which must be researched before a systematic body of evidence is accumulated in relation to mastery learning.

In addition to the four presenters of research studies, we are fortunate in having with us critics Dr. Block and Dr. Allen. Dr. James Block, of the University of California, Santa Barbara, has published a number of monographs dealing with mastery learning, and Dr. Ian Allen, of Simon Fraser University, has conducted research in social studies relating to curriculum development using Ausubel's construct of advance organizer. As most critics, they have been on the short end of receiving papers somewhat late, but they have had an opportunity to see these papers before making their comments.

For the purpose of this symposium, I will define mastery learning as a combination of the task-constant time-variable of Washburn, (Washburn 1922; Washburn, Vogel, and Gray, 1926) with the teach-test-reteach schema of Morrison (1925). The construct was first used in educational literature by Bloom in 1968, in which he incorporated elements from Carroll's 1963 model of school learning. Specifically, Bloom suggested mastery learning as one possible teaching-management solution to the problem of increasing the performance of low aptitude students.

VARIABLES IN MASTERY LEARNING

by

Marion J. Rice, University of Georgia

Research in mastery learning is difficult to appraise, primarily because the reports of such research are not clear as to the variables investigated. On the whole, most mastery learning research falls into the category of crude comparisons of an experimental mastery treatment with a control treatment which is alleged to use "traditional" methods of instruction. An exception to this low-level of research is the pioneering study of Block (1970) in which he attempted to identify the relationship of criterion performance level to attitude as well as cognitive achievement.

Table 1 succintly presents some of the most important independent and dependent variables in mastery learning. A longer list is included in Appendix A, which indicates more specifically some of the sub-variables which might be investigated. Appendix B indicates a hypothetical and cumulative research sequence which is necessary to establish a body of reliable knowledge about mastery learning. Table 1 and Appendix A indicate the complex task of systematically developing a body of knowledge in contrast to a position of advocacy relating to mastery learning. A quick scan of these mastery learning variables will also indicate that the variables are not unique to mastery learning, but must be addressed in any systematic program to facilitate learning, irrespective of the label addressed.

The following paragraphs do not exhause the relevant literature, but are simply used to indicate dimensions of the research task.

Materials. Carroll & Spearritt (1967), Bloom (1968), and Block (1971) have emphasized the importance of such material factors as learning tasks, testability of objectives, structured content, clarity, and sequencing. But no mastery study has systematically investigated material variables. Studies which have investigated material alternatives have been concerned with conceptual styles of the learner (see below). Among various material paradigms which might be investigated in the context of mastery learning are the stimulus-response model of Skinner (1968); the rule-egrule contrast (Hermann, 1971); structure-of-the-discipline as process (Bruner, 1960) and as concept organization (Michaelis, 1967); and the verbal reception model of Ausubel (1963). Verbal reception is one of the most complete models for the curriculum and school instruction (Rice, 1972), but only the advance organizer has been investigated (Rice, Barnes, & Clawson, 1972), with no attention to the principles of generality, subsumption, and integration.

Instructional procedures. The mastery literature abounds in general descriptions of instructional procedures, such as the use of formative tests (Airasian, 1967; Block, 1970; Mayo, 1968; Moore, Mahan, & Ritts, 1963),

TABLE 1

Independent and Dependent Variables in Mastery Learning

Independent	Dependent
1. Materials	1. Time to Criterion
2. Instructional Procedures a. Presentation and Remediation b. Management	2. Achievement Level 3. Attitude Toward Learning 4. Perseverance
3. Pupil Characteristics a. Aptitude b. Perseverance c. Other	
4. Teacher Characteristics	
5. Criterion of Mastery	
6. Classroom Environment	
7. Duration of Mastery Sequence	

course objectives (Biehler, 1970); self-paced small units with review (Gentile, 1970); personalized self-pacing with tutors (Green, 1969); teacher-directed with proctors (Keller, 1968); teacher directed with feedback and review (Kersh, 1970); step-by-step explanation of missed material (Merrill, Barton, & Wood, 1970); a combination of teaching methods by group size (Postlewait, Novak, & Murray, 1964); and a system of multiple procedures (Kim, 1970).

These total procedures involved students in more time to attain criterion, but they do not indicate the optimal procedural elements of presentation and correction by subject, age, and aptitude which might be optimal. Only Collins (1967) compared six different treatments, one per class of 25 subjects each in eighth grade mathematics. In general, he found that complete, more prescriptive procedures were more effective than incomplete, less prescriptive procedures, but there was no study of the interaction of pupil aptitude and instructional procedures.

Criterion to mastery. The stipulated criterion may be both a dependent and an independent variable. As an independent variable, different mastery criteria may be selected, and the interaction of aptitude and criterion observed, especially for attitudinal and perseverance effects. Block (1970) is apparently the only empirical study in which differential criteria and aptitude have been used as experimental variables. He concluded that, over all, an intermediate level of 85 percent is maximally related to positive cognitive and affective developments. This eight grade study in matrix algebra involved 91 subjects, 17 of whom were lost before data analysis. Because of the relationship of criterion to possible frustration (Seashore & Bavelas, 1942), the interaction of aptitude and criterion level is important Block, like Bloom, has shown more concern with the affective consequences of mastery than has Carroll. Carroll and Spearritt (1967) report that interest was a negligible factor in learning an artificial language, but they were not concerned with the effects of differential criterion.

Teacher characteristics. Kim (1970) and Gaines (1971) have reported great differences in mastery learning by teacher and school. Notwithstanding the fact that teacher ability to manage instruction is to Carroll (1963) synonymous with the quality of instruction, there has been no systematic investigation of the relationship of teacher characteristics to pupil mastery. In part, this may be due to the long tradition of describing the characteristics of good teachaers (Barr, 1929; Hart, 1934; Ryans, 1960; Bledsoe, 1967) rather than experimentally verifying teacher characteristics in relation to pupil achievement, as in Heil, Powell, and Pfeiffer (1960) and in Spaulding (1963). The latter two studies indicate the importance of matching teacher and pupil characteristics.

Pupil characteristics. Three pupil traits have been considered in mastery learning--aptitude, conceptual style, and perseverance. Aptitude is a significant variable in mastery learning, and frequently predictive of time to criterion (Carroll, 1963, 1971; Bloom, 1968). The evidence is too limited to assume that mastery learning procedures may homogenize performance

(Block, 1972). Even in optimum IPI (Glaser, 1968) and CAI (Atkinson, 1968) instructions the most able students were able to achieve five times as much as the slowest students, a confirmation of Washburn's observation (1926).

Some interest has been shown in the relationship of specialized figural-semantic traits to mathematics performance (Behr, 1967; Davis, 1967; Kim, 1968). Block's interpretation (1971) of the importance of tailoring materials to special aptitudes does not square with Cronbach's synthesis (1969) that few interactions of aptitude-treatment in the research are confirmed, largely because of weak conceptualizations of aptitude and treatment and the brevity and artificiality of the studies. A promising avenue which might be pursued in connection with mastery learning is Hunt's formulation (1970, 1972) that student conceptual level is inversely related to the need for structured materials and procedures.

Perseverance is a factor in the original Carroll (1963) model, but this factor has not been experimentally studied. In 1967 Carroll shifted his emphasis from the measurement to the enhancement of perseverance through teacher praise and reward. A useful summary of research relating to differences in cognitive, affective, and personality styles is given in Messick (1970).

Classroom environment. A correlational study by Anthony (1967) found a medium positive correlation on post-achievement with factors on a Classroom Environmental Index. The most important of these factors, however, related to instructional procedures.

Coleman (1966) reports that variation in facilities makes a greater difference for minority students rather than for white students. Difference in school quality may therefore be independently related to achievement, apart from other mastery variables. The press to achieve appears to be an important environmental factor (Coleman, 1966), which is related to student body composition.

Duration of a mastery sequence. Carefully conducted mastery studies, where experimental time has been given, indicated short-run rather than long-run studies. Studies lasting for a quarter or a semester have been loosely conducted, whole group studies of intact classes, at the college level. The Block (1970) study lasted five days, including post-test time.

The long term viability of a mastery strategy has not been the subject of research.

Management problems. The implementation of mastery teaching involves particular management problems, especially in the techniques of providing adequate time for the lower aptitude student. The technique in college of permitting students to carry over work from one semester to another is not applicable to the elementary level. Sherman (1967) reports that 39 percent of students did not complete the course until the following semester.

A review of the four studies which will be reported by the presenters is summarized in Appendix C. A review of Appendix C will indicate that the title "Variables in Mastery Learning" is probably misleading. The variables, in the context as used in this section, were not systematically manipulated, so what we have are essentially characteristics of the various studies. All of these four studies indicated, however, that high aptitude students learned more and retained more than low aptitude students. It seems, therefore, that we should be very cautious in making claims that mastery procedures may overcome the unsuccessful performance of low aptitude students in social studies.

A second observation is that three of the four studies involved large numbers of subjects, and used a unit of statistical analysis other than the individual. This is an example of attempting to make the unit of analysis more or less equivalent to the unit of treatment, in accordance with the admonition of Glass and Stanley (1970, 505-508). The result was to impose on the investigator a large number of classes and subjects, and make it impossible for the investigator to do little more than compare one so-called mastery treatment with another treatment, without any actual knowledge of the extent to which treatment procedures were being followed. I have therefore taken a research resolution that future investigations of this nature will involve small samples so that the investigator can observe and collect data on instructional processes as well as collect statistical data. Furthermore, the data collected on the relationship of the concomitant variable, pupil aptitude, inclines me to believe that the pupil is the performing unit, and therefore the appropriate unit of analysis, notwithstanding group instruction and statistical concerns relating to independent response.

At this point, so that I will not intrude on either the domain of our presenters of our reviewers, I would like to call on each of the presenters.

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Appendix A
Independent Variables in Mastery Learning

Materials

- Analyses
  - Identification of learning tasks and hierarchies
    - Arrangement in sub-tasks
- Specification of objectives
  - Tasks to be learned stated in testable form
- Development of materials: clarity
  - Controlling vocabulary and conceptual load
  - Writing to emphasize clarity
  - Writing to emphasize comprehensibility
- Development of materials: structure
  - Simple-complex, whole-part, prerequisite learning, chronological
  - Advance organizer, generality, subsumption, progressive differentiation
  - Ruleg, egrule
  - Conceptual clusters
  - Structure of discipline
  - Sequenced, closed, convergent
- Development of remediation materials
  - Alternative materials: texts, workbooks, programmed texts, A-V, simulation
- Evaluation instruments
  - Formative tests
  - Summative tests

Instructional Procedures

- Providing materials suitable to learning task
- Adjusting rate of presentation to pupil aptitude
- Having pupil understand the objectives of instruction
- Monitoring pupil progress
  - Uses formative evaluation as part of instruction to diagnose difficulties
  - Provides feedback
  - Provides remediation through review, practice, and reteaching
- Motivates: praises and rewards good performance
- Encourages perseverance
- Gives opportunity to learn
  - Provides time needed to achieve summative criterion

Pupil Characteristics

- Aptitude
- Ability to Understand Instruction
  - Verbal
  - Listening
  - Comprehension
- Perseverance
- Prior learning: how much a student knows of subject prior to learning

Teacher Characteristics

- Grasp of Subject Matter
- Ability of Teacher to manage course of instruction

Classroom Environment

Criterion of mastery: variations in prescribed mastery level
Duration of mastery sequence

Appendix B

Suggested Cumulative Sequence for Independent and Dependent Variables

Phase 1	Materials		
Materials x Aptitude : Achievement	Materials x Pupil Characteristics :	Materials x Pupil Characteristics Teacher Characteristics : Achievement Attitude	Materials x Pupil Characteristics Teacher Characteristics : Achievement Attitude Perseverance
Management	Management	Management	Management
Phase 2	Mastery Model (Materials, Presentation and Correction Procedures)		
Mastery Model x Aptitude : Achievement Time to Criterion	Mastery Model x Pupil Characteristics Teacher Characteristics : Achievement Time to Criterion	Mastery Model x Pupil Characteristics Teacher Characteristics Criterion Levels : Achievement Attitude Time to Criterion	Mastery Model x Pupil Character- istics Teacher Character- istics Classroom En- vironment Criterion Levels : Level of Achievement Attitude Perseverance Time to cri- terion
Management	Management	Management	Management
Phase 3	Duration of Mastery Sequence (seven months)		
A series of successive studies in the format of the Phase 2.4 model			

Appendix C

VARIABLES IN LEARNING

VARIABLE	Contreras 1975	Jones 1974	Fagan 1975	Myers 1975
INSTRUCTIONAL MATERIAL				
Subject Matter	Geography	Geography	Geography	Geography
Title	Population Growth Mexico & U.S.	Functions of Cities	Transportation and Environment	Man Shapes the Earth (de Blij)
Nature of Content	Basic skills and concepts of population geography; factual information on population growth using comparative approach	Concepts and generalizations relating to different functions of cities; factual information about specific cities	Concepts and generalizations relating to different kinds of transportation; specific factual information	Topical introduction to the broad field of geography, using 10 major topics
Format of Material	Individual self-study text using constructed responses inferred from a data base to incomplete sentences (FIRM)	Individual self-study narrative text and constructed response workbook	Narrative recorded on tape text and workbook	Narrative text
Publisher	Ga GGY Project 72	GA GGY Project 74	Georgia GGY Project 75	Hamilton, 1974
GRADE LEVEL	7	7	7	Col. Freshman
SAMPLE				
Number Schools	5	4	2	1
Number Subjects	734	539	533	34
Number Classes	24	20	17	2
Subject Loss	4%	7%	47PT99Reten	10%
No. Teachers	5		4	1

MASTERY (x) AND NON-MASTERY (0) TREATMENT	Contreras	Jones	Fagan	Myers
Method	Self-Instructional	Self-instructional	Class-paced	Class-paced
PRESENTATION (First Treatment)				
Teacher Instruction	Assigned tutor text	Assigned tutor text	Introduced Advanced Organizer and Key Concepts	Assigned Text
Narration Workbook Exercises	Studied FIRM Completed Exercises	Studied text, Completed workbook, activities	Read text with taped Narration, Explanations by teacher Completed review sheet	Class lecture and discussion
DIAGNOSIS				
Test Administered	None. Each lesson measured against criterion	Formative Test	Formative Test	Formative Test
Criterion Level	90, 80, 70%	85%	80%	85%
REMEDIATION - 0	If criterion not attained, review data base	If criterion not attained, study keyed items missed	If criterion not obtained, study keyed items missed; Teacher drill on items missed	Tutorial assistance
- 0				
Second Test Administered	If criterion not attained, go to next lesson	If criterion not attained, go to next lesson	If criterion not attained, go to next lesson	If criterion not met, go to next lesson
Summative Test	X	X	X	X

	Contreras	Jones	Fagan	Myers
DURATION OF STUDY				
Inclusive Time	15 days	20 days	25 days	50 days
Treatment Time	14 days	19	24	
Elapsed Time Before Retention Test	21 days	17 days	28 days	N.A.
Review before retention Test	None	No	No	N.A.
Non-Mastery			20	
CONCOMITANT VARIABLE				
Knowledge of word Meaning	Iowa Test of Basic Skills Level 13 ITBS, Forms 5 & 6, 1971, Vocab. Sub. Test, 17 min. test	IBNS	ITNS	SAT Verbal
MEASURES OF RESULTS				
Cognitive Achievement	Dale Summative Test, 50 items, 4-foil, multiple choice, 1972 KR #21 reliability 91; Contreras sample Cronbach Alpha Indices .95 (p.85)	Investigator constructed 40-item, 4-foil, Cronbach Alpha r. 89; 24 item recall, Cronbach Alpha r. 95	Investigator 40-item, 4, foil, multiple choice test, Cronbach Alpha r. 86 achievement and retention	Investigator constructed, 50-item, 4-foil, Cronbach Alpha reliability of .78
Affective	Remmers, Form A, Attitude Toward Any Subject Scale (p. 87), Short Form	-------	-------	Remmers, Form A, Attitude Toward Any Subject Scale, Short Form, r (Cronbach's Alpha), .29
Time	Number of lessons completed by treatment and vocabulary level	Minutes to testing by treatment and aptitude	Number of days in teaching mastery and non-mastery	Amount of time spent in tutorial sessions above class time of 50 days

VARIABLE	Contreras	Jones	Fagan	Myers
RESULTS				
Cognitive Achievement	No significant difference in achievement and retention measure by treatment,	N.S.D. in Achievement by Treatment for high and low aptitude	N.S.D. Achievement by Treatment	N.S.D. in Achievement by Treatment
Retention	i.e., 90%, 80% and 70% criterion levels	S.D. in Retention by treatment for high & middle aptitude students	N.S.D. in Retention by Treatment	****
Attitude	N.S.D. in attitude toward treatment by criterion level	-------	-------	No differences between attitudes of various aptitude groups by treatment and class
Vocabulary	Vocabulary knowl. sig. .001 level for achievement and retention but not for attitude	Vocab. know. sig. .05 level achievement and retention but not times-to-testing	r= .95 and achievement r = .89 and retention	Statistically significant interaction by treatment and SAT verbal for low aptitude students
Time by Criterion Level or Treatment	The higher the criterion level, the higher rate of non-completion of lessons	Took sig. more time to complete mastery than non-mastery unit	20 days for non-mastery v. 25 days for mastery	Most any student spent in tutorial was no more than 10% of class time, but those with 100% attendance in tutorials passed summative test compared with those who attended less than half
Time by Vocabulary	The higher the vocabulary level, the higher the completion rate of lessons	Higher vocab. level, the less amount of time to completion		

DATA ANALYSIS	Contreras	Jones	Fagan	Myers
Blocking Concomitant Variable	Vocab Knowl	Vocab Knowl	Vocab Knowl	Verbal Aptitude
Results Measures	Post-Test and Retention	Post-Test and Retention	Post-Test and Retention	Post-Test
Unit of Analysis	Aptitude group within class by treatment, i.e., criterion level	Aptitude group within class by treatment	Intact Class	Individual Pupil score
Principal Means of Analysis	Analysis of Variance (ANOVA)	Multivariate Analysis of Variance (MANOVA)	Stepwise multiple regression and analysis of covariance	Multivariate and Univariate analysis of Variance
Significance Level	.05	.05	.05	.05
Analysis	3 x 3 fully crossed analysis of variance with achievement, attitude, and retention scores as criterion measures	3 x 10 x 2 aptitude by classes-nested within-treatment, by treatments	Multiple regression of the relationship between achievement and retention and ability, treatment, and teacher independent variables	2 x 2 x 3 completely crossed treatment by aptitude multivariate analysis of variance with achievement and attitude as effects measures